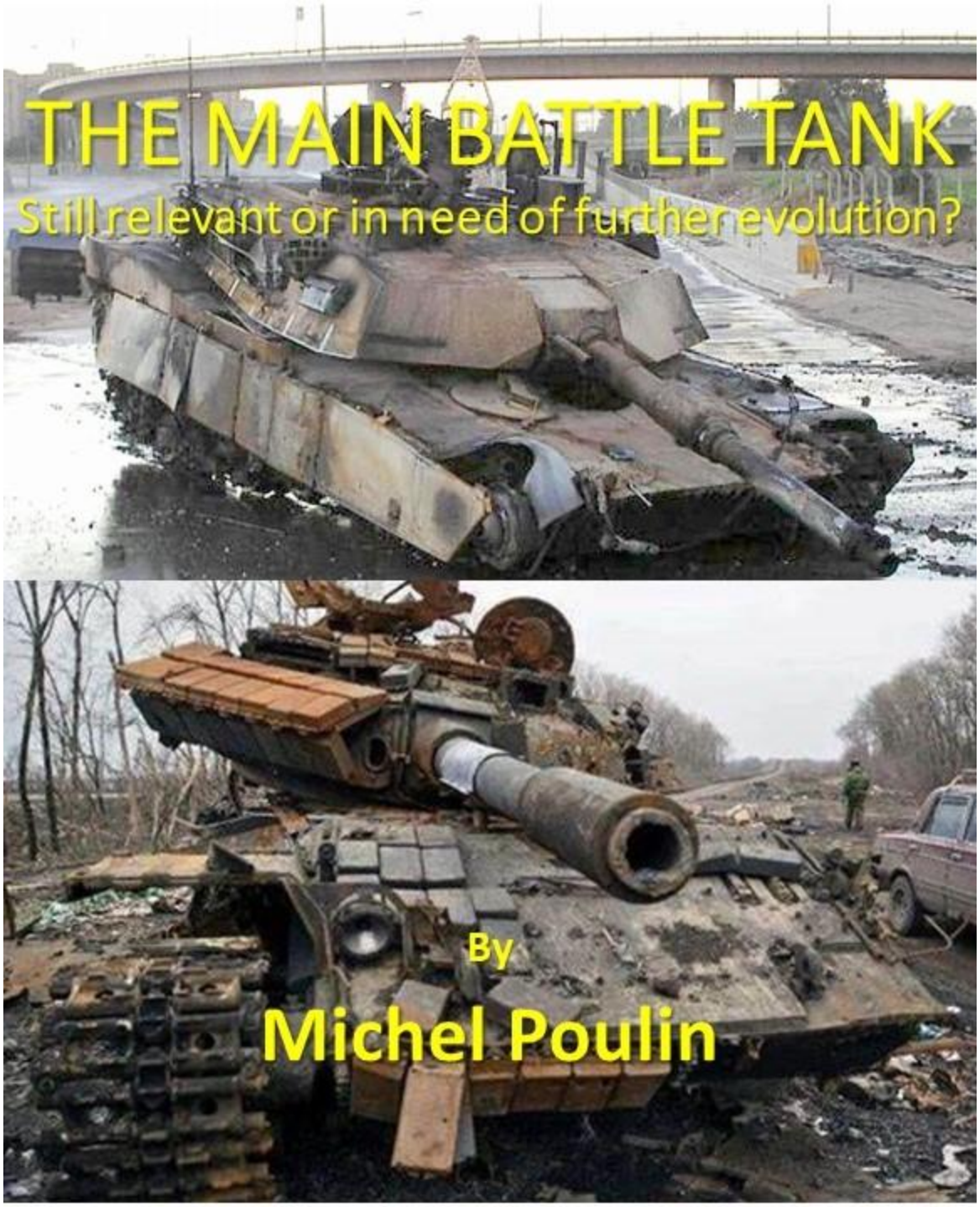
THE MAIN BATTLE TANK
Still relevant or in need of further evolution?
By
Michel Poulin

THE MAIN BATTLE TANK

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A NON-FICTION MILITARY ESSAY

BY

MICHEL POULIN

NOTE TO POTENTIAL READERS

THIS NON-FICTION ESSAY IS MEANT TO EXAMINE THE FUTURE OF MAIN BATTLE TANKS IN LIGHT OF THE COMBAT LESSONS FROM PAST AND PRESENT WARS. IT IS NOT MEANT TO DESIGNATE A PARTICULAR TYPE OF MAIN BATTLE TANK AS 'BEST OF THE LOT' BUT RATHER TO EXAMINE IF THE CONCEPT OF MODERN TANKS AS KNOWN TODAY IS STILL VALID OR IF IT NEEDS TO EVOLVE UNDER THE PRESSURE OF MODERN ANTI-TANK WEAPONS.

ABOUT THE AUTHOR

The author is a retired member of the Canadian Forces with 32 years of service, first as an infantryman, then as an intelligence specialist. These 32 years of service include a total of five and a half years served overseas (Germany, Cyprus, Lebanon, Bosnia) and exposure to active war conditions (Lebanon Civil War, the 1982 Israeli invasion of Lebanon, the conflict in Cyprus in 1975). The author was qualified on and fired numerous types of weapons during his military career, including the M40 106mm recoilless gun, the CARL GUSTAV 84mm recoilless gun, the M72 anti-tank rocket launcher and the TOW anti-tank guided missile, on top of being qualified on numerous types of small arms (rifles, pistols, submachine guns, machine guns, grenades) and as a driver for the M-113 armored personnel carrier. He also was a foreign weapons instructor at the Canadian Forces Security and Intelligence School and made the analysis and study of weapons and of wars his specialty. While now retired from the service, he continues to closely follow the various developments in modern weapons systems, along with the military and geopolitical events around the World.

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British Mark IV tank of the First World War.

THE FIRST WORLD WAR: APPARITION AND FIRST STEPS.

What we now call a 'Tank' was mostly born out of the butchery of World War 1 trench warfare, when soldiers were faced with the murderous task of attacking through a no-man's-land of open terrain swept by machine gun and artillery fire and with deep lines of barbed wire blocking the approaches to enemy trenches. Both the Allied armies and the German army repeatedly lost thousands and tens of thousands of soldiers in order to gain only insignificant amounts of ground. While searching for a way to diminish those painful losses, the British, inspired by Winston Churchill, then First Lord of the Admiralty, set up in 1915 the 'Landships Committee', to explore the subject of cross-country armored vehicles. The name 'tank' was used by the Landships Committee to hide the real purpose of their work. The first iteration, 'Little Willie', appeared in 1915 but did not see combat. The first armed 'landships' to be successfully tested appeared in early 1916, armed with two naval 57mm guns and three machine guns. Nearly simultaneously and quite independently from the British efforts, the French also started developing their own models of tanks. Those British and French first tanks were crude affairs, lightly armored, very slow and unreliable and with very limited autonomy. Their

main task was to help the infantry assault enemy trenches, not to fight other armored vehicles.

The first use of tanks in combat by the British was on 15 September of 1916, at the Battle of the Somme, when 49 tanks went on the attack. However, they were committed in small groups and not as a coherent, concentrated unit and they achieved little success, apart from terrorizing the German soldiers who first saw them. The British learned their lessons from that failure and struck in force at Cambrai on 20 November of 1917, when 476 British tanks attacked on a concentrated front in a surprise assault which achieved a spectacular success. However, that success in Cambrai also demonstrated the slowness and lack of range of the early British tanks. The British then introduced into service a lighter and faster tank, the Medium A, which was first used in combat in Amiens in August 1918 as part of a 600-strong tank force. In the meantime, the French Army produced over 3,000 of its own tanks, the great majority of which were **Renault FT** light tanks, designed and built to accompany and support assaulting infantrymen. It did well in that role but had no capability to engage other armored vehicles. While the first tanks were mostly immune to rifle and machine gun fire, their first serious enemy proved to be artillery guns, firing either in indirect or direct fire mode, a fact that the Germans were quick to seize on. A direct artillery shell impact on an early model of tank invariably resulted in the utter destruction of the vehicle. The slowness and lack of agility of those tanks only made them easier targets to artillery gunners, resulting in significant losses, with the notorious mechanical unreliability of the early tanks adding to the casualty count.

THE INTERWAR YEARS: INFANTRY TANK; CRUISER TANK; HEAVY TANK.

When World War One ended in 1918, the Allies found themselves with thousands of early tank models in their inventories. The United States and Italy had also built tanks copied from British and French designs. Military thinkers then started working on improving both the designs and the combat doctrines and uses of tanks. In Great

Britain, the British tank doctrine evolved into classifying tanks in two main categories: the infantry tank, slow but well armored, meant to accompany assaulting infantrymen; and the cruiser tank, a faster vehicle meant to push into enemy lines and penetrate deeply. One such infantry tank developed during the interwar years was the French Renault R-35, which became the most numerous French tank type by 1940.

The concept of using tanks in massed, concentrated units rapidly spread, but the notion of dividing tank designs in 'infantry tanks' and in 'cruiser tanks' remained, especially in Great Britain. The British formed tank brigades, meant to closely cooperate with the infantry, and armored divisions designed to exploit in-depth penetrations of enemy lines. The French similarly adopted two types of tank formations: the 'Divisions Légères Mécaniques[1]', meant to rush through holes in enemy defenses; and the heavier, more powerful 'Divisions Cuirassées'[2], whose principal role was to assault enemy positions. On their part, the Soviets divided their tank forces into light tank battalions, maneuver brigades and mechanized brigades. In contrast, the German Army created its first Panzer divisions in the mid-1930s, but also adopted new doctrines meant to closely integrate the operations of all its arms, combining great firepower and high mobility. Its defined roles were rapid concentrations of fighting power, breakthroughs, deep penetrations on wide fronts and destruction of the enemy.

Before the First World War ended in 1918, work had started on the development of much heavier tanks than before, armed with 75mm guns and weighing twenty tons or more. In France, this eventually produced by 1937 the 27-ton CHAR B.1, designated as a 'Char de Bataille'[3]. On their part, the British produced the INDEPENDENT heavy tank, an aberration with no less than five separate turrets, with the Soviets following suit with their own T-35 heavy tank.

WORLD WAR 2: EVOLUTION FROM COMBAT EXPERIENCE.

By the time World War 2 started in 1939, Great Britain operated two main types of tanks: the MATILDA II infantry tank and the CRUSADER cruiser tank. The Germans, on their part, operated a mix of light and medium tanks at first, then concentrated on

[1] Divisions Légères Mécaniques : French for Light Mechanized Divisions.

[2] Divisions Cuirassées : French for Armored Divisions.

[3] Char de Bataille : French for 'battle tank'.

producing medium and heavy tanks of increasingly more powerful and better armored designs. In 1939, the mainstays of the German Panzer divisions were the PANZER II light tank, armed with a 20mm cannon, the PANZER III medium tank, armed with a short 50mm gun, and the PANZER IV, armed with a short 75mm gun.

On the French side, the war was started with a mix of light, medium and heavy tanks: the Renault R-35 light tank; the Somua S-35 medium tank and the CHAR B1-bis heavy tank. Of them, the CHAR B1-bis proved the most troublesome to the Germans, while the S-35 also gave a good account of itself. Unfortunately, the French doctrine concerning the use of tanks greatly hindered their efficiency in combat by diluting them into small groups while facing the concentrated punch of the German Panzer divisions.

The Soviets, who were attacked by the Germans in 1941, also started the war with a mix of light, medium and heavy tanks, the most famous of which was the T-34 medium tank, which would prove to be a very nasty surprise to the Germans, as its design philosophy was quite close to that of the modern main battle tank, with a good balance of firepower, mobility and protection. It also was one of the first tanks to fully use the concept of sloped armor in order to augment the protection against armor-piercing projectiles. Its only main drawbacks were its 2-man turret, which overloaded its crew and particularly its commander, and its total lack of crew comfort features. In turn the apparition of the T-34 pushed the Germans into hastily designing and producing a counter, the PANZER V PANTHER, which would itself become famous (or infamous, depending on whose side of it you ended up). At about the same time as the PANTHER entered service at the end of 1942, the German Army fielded a new heavy tank, the PANZER VI TIGER, another tank that would make a lot of ink (and blood) flow. At the same time, the Germans rearmed their older medium tanks with longer, higher velocity guns, so they could pierce the armor of the Soviet medium T-34 and heavy KV-1 tanks.

In comparison, the United States started the war behind the other nations, fielding at first a number of light and medium tanks of dubious designs, before finally settling on the M4 SHERMAN as its main tank type. It had a short 75mm gun, inadequate protection and very high silhouette, the latest a distinct tactical disadvantage in combat. Despite its shortcomings, the SHERMAN was massively produced during the whole war, in order to capitalize on its reasonable weight, which facilitated its transport

overseas, and on the huge industrial capacity of the United States for mass production. While the SHERMAN too often ended with the short end of the stick when facing the PANTHER or the TIGER, it eventually ended up winning through sheer weight of numbers.

By the end of World War 2 in 1945, all the combatants had produced or had designed medium and heavy tanks which incorporated the numerous lessons of the war about armored warfare and tank design and doctrinal use. However, due to the huge number of older models produced during the war and to the high costs of the conflict, which produced large war debts, the widespread fielding of the newer models after 1945 proved to be slow, although much work went into the study and design of more advanced tanks which would conform to what we would now call main battle tanks.

CHAPTER 2 – THE EMERGENCE OF THE MAIN BATTLE TANK

A British CENTURION tank during a field exercise in the 1950s.

WHAT MAKES A MAIN BATTLE TANK?

The official military definition of a main battle tank, or MBT in short, is 'a mobile, protected gun system' possessing a mix of firepower, mobility and protection. The ratio of each of those three elements will vary quite a lot between the various types of modern tanks which entered service after the end of World War 2, with that ratio greatly influenced by the national tank philosophy and thinking about tank design and doctrinal use particular to each country concerned. Ideally, a good MBT would possess all three qualities in a judiciously balanced way. However, what makes a good tank in one country will not always be similar to what is believed or accepted in another country.

FIREPOWER

War is like Christmas: it is better to give than to receive. (CHALLENGER 2)

MOBILITY

How do I get out of here? HELP! (T-72)

PROTECTION

(Or the constant requests for more of it!)

Things are getting a bit hot around here! (M1 ABRAMS in Iraq)

POST – WORLD WAR 2: FIRST TANK COMBAT EXPERIENCES

It didn't take long after the end of WW2 before more wars gave the opportunity to combatants to test their new tanks and doctrines in combat. First came Israel's War of Independence in 1948, pitting the newly created Jewish state of Israel against its Arab neighbors. However, that war, following so close after WW2, involved mostly old, second-hand weapons and vehicles. So, few valuable lessons were taught by it, apart from showing again the importance of resolve and belief in a cause. Next was the Korean War of 1950, a much more vast and complex affair pitting American and British equipment against Soviet equipment. As armored warfare was concerned, the results of tank duels during that war showed again that competent handling and good tactics often gave the edge over a resolute and numerically superior but poorly trained enemy tanker force. The American M-26 and M-47 tanks proved more than a match for the T-34/85s of the North Korean Army and so was the case for the British CENTURION tanks which

fought in Korea. Another lesson relearned then was that tanks fighting without infantry support were vulnerable to infantry swarm tactics, especially at night. In truth, a seasoned infantryman will tell you that a tank with hatches closed may be scary, but that it is also a big but myopic beast when dealing with foot soldiers surrounding it.

The next series of wars, around the Middle East and in Indochina, while bloody and intense, did little to teach new lessons about armored warfare, until the Yom Kippur War of 1973 that is. That war, fought between Israel and a coalition of Arab states during nineteen days in October of 1973, featured two important events which heavily influenced the future of armored warfare. The first one was the successful mass use for the first time of anti-tank guided missiles by the Egyptian Army against Israeli tanks. The second was the intense and bloody fighting opposing hundreds of Israeli and Syrian tanks on the Golan Heights and opposing Israeli and Egyptian tanks in the Sinai Peninsula. While the tank battles on the Golan and in the Sinai, which pitted Israeli CENTURION and SUPER-SHERMAN tanks against Syrian and Egyptian Soviet-made T-54/55 and T-62 tanks, were epic, the true shocker for the tanker world was how Egyptian infantrymen equipped with portable AT-3 SAGGER anti-tank guided missiles and RPG-7 anti-tank rocket launchers managed to stop cold the Israeli tank counter-attacks meant to repel the Egyptian forces which had crossed the Suez Canal. After crossing the Suez Canal, the Egyptian anti-tank teams were told to run as fast and as far as they could and then stop and set up anti-tank ambushes. When the Israeli tankers, mostly equipped with CENTURION and SUPER SHERMAN tanks, rushed forward without proper infantry support, they were decimated and stopped cold by dense AT-3 missile fire from distances of up to 3,000 meters. On its part, the fighting on the Golan Heights featured for the first time the mass use of infra-red night vision equipment mounted on the Syrian tanks. The Egyptian and Syrian forces also showed good interarm tactics by keeping at first their ground forces under a dense anti-aircraft umbrella provided by SA-6 surface-to-air missile batteries and by ZSU-23-4 radar-pointed self-propelled anti-aircraft guns. While Israel eventually prevailed in this conflict, the alert had proved to be an unsettling and costly one for the Israeli forces, especially for their tank units and fighter-bomber squadrons. The lessons from the Yom Kippur War were thus carefully noted around the World and contributed to the development of future main battle tanks.

CHAPTER 3 – NATIONAL EVOLUTION TRENDS OF THE MBT

British CENTURION main battle tank

Soviet T-62 main battle tank

Swedish Strv-103 S-Tank

Israeli MERKAVA main battle tank

BRITISH MAIN BATTLE TANKS

After WW2. the British opted to rely on a mix heavy on firepower and protection, while keeping a reasonable minimum of mobility. They also abandoned at long last their policy of having both infantry tanks and cruiser tanks, which had done so much damage to tank development in Great Britain. They by then relied mainly on the 49-ton CENTURION, armed with an 83.8mm, 20-pounder gun. However, in order to counter the Soviet IS-3 STALIN heavy tank, armed with a 122mm gun, the British also developed a heavy tank of their own armed with a 120mm gun. The result of those studies was the 65-ton CONQUEROR, which entered service in 1956. However, the CONQUEROR did not stay in service for very long, contrary to the CENTURION, and was withdrawn from service in 1966. The successor of the CENTURION, entering service in 1963, was the 56-ton **CHIEFTAIN**, armed with a long and very accurate rifled 120mm gun. When introduced into service, the CHIEFTAIN was considered the most

powerfully-armed and most heavily armored battle tank in the World. However, it was heavily criticized as being too heavy and having poor engine reliability and lackluster mobility. Still, 770 CHIEFTAIN tanks were built from 1966 on into the 70s. The CHIEFTAIN was then succeeded by the new CHALLENGER as the main tank of the British Army. This MBT, weighing up to 70 tons with additional armor modules in its latest variant, entered service in 1983, is armed with a long rifled 120mm gun and is heavily armored, continuing the British trend of emphasizing firepower and protection over mobility. The British Army later fielded the 75-ton **CHALLENGER 2** and is presently working on the CHALLENGER 3 variant, with even better protection and with an improved fire control system.

AMERICAN MAIN BATTLE TANKS

The Americans ended WW2 with a huge number of M4 SHERMAN of various models still in service, thus were fairly slow in procuring more modern tanks in sizeable quantities. The first of the post-war models was the **M-26 PERSHING**, which actually barely had time to be rushed to Europe to participate in the final combats. The M26 was a 42-ton machine armed with a long 90mm gun. It then progressively evolved along the years, with the M47, M48 and M60 following it in production. The **M60** finally introduced into service the 105mm gun, which was also arming numerous other models of European-produced tanks and became a NATO-standard tank gun.

M26 PERSHING

M60A1

In 1980, a new main battle tank entered service with the U.S. Army: the M1 ABRAMS. Its initial version was armed with a 105mm rifled gun, which was soon replaced in the M1A1 variant by the same 120mm smoothbore gun which equips the German LEOPARD 2. The latest variant of the M1, the A2 SEP, tips the scale at a

whopping 66.8 tons, thanks to added armor packages, making it one of the heaviest tanks in existence today. Its 1,500-horsepower turbine engine provides it with good mobility, but also proved to guzzle fuel at a heavy rate, forcing it to pay close attention to its accompanying supply lines, something that adds a certain vulnerability to it in combat operations. With over 10,000 M1 of all variants produced to date and still in production, the ABRAMS is the mainstay of the U.S. Army and has fought in numerous wars around the Middle East through the years, including in Iraq and Afghanistan. It was also exported to a number of allied countries, including Saudi Arabia, Egypt, Kuwait, Iraq and Australia. The United States is presently working on a program for a future main battle tank meant to succeed the **M1 ABRAMS**.

SOVIET MAIN BATTLE TANKS

Post 1945, the Soviets, who continued to rely heavily on their huge fleet of T-34 tanks, now armed with 85mm guns, vied to design their new tanks with a mix of qualities geared towards a well-protected, well-armed and highly mobile combat vehicle. However, ergonomics and crew comfort seemingly never entered that mix, with long-term negative consequences in the long run for the combat efficiency of the poor Soviet crewmen. The successor of the T-34, produced as early as 1948, was the 35-ton T-54, which was progressively improved into the **T-55**. Both the T-54 and the T-55 were armed with a long 100mm gun and had turtle-shaped turrets meant to deflect incoming projectiles. They had good firepower for their time and also had adequate protection but, ergonomically, were very hard and tiring on their crews, with the driver in particular having to constantly fight with a hard-to-operate manual transmission. The T-54/55 went on to be copied and produced in the thousands by other communist countries, including China, Poland and Czechoslovakia, while many other armies around the World also adopted it, particularly in the Middle East. Also produced in some quantity after WW2 was the **IS-3** heavy tank, armed with a long 122mm gun and generally regarded as a formidable tank.

T-55 main battle tank

IS-3 heavy tank

The next generation to enter service in 1973 was the **T-72** main battle tank, produced in many variants progressively improved/modified along the years and still in production and service, with over 25,000 copies built and exported to many countries. The T-72, the related T-64, T-90 and the gas turbine-propelled T-80 variant are all armed with a 125mm smoothbore gun, which can also fire guided missiles through the tube in the more recent variants. The 125mm gun also uses an automatic loader system, which allowed the Russians to keep the crew to three men. Overall, the T-72 shows the typical even balance between firepower, mobility and protection followed by the Soviet and then the Russian Army. Its fire control system, while much more modern than that of its predecessors, is still lagging a bit behind those of the latest western tank designs, but its main gun packs a serious punch. While its overall protection level is decent and was further improved in many of its models by the addition of **explosive reactive armor (ERA)** bricks, the T-72 has shown its internal ammunition layout to be vulnerable to penetration, which then often makes the gun ammunition explode when hit by projectiles or shaped charge jets, resulting in the catastrophic destruction of the tank. This vulnerability has been demonstrated numerous times in past wars and is still a weakness, as shown by the continuing

slaughter of Russian tanks falling victims to anti-tank missiles in the war in Ukraine, where over 300 Russian tanks have been destroyed, as of early April. As per other Russian tanks, the T-72 is a cramped vehicle for its crew, while the smaller than usual three-man crew results in less manpower available for the daily necessary maintenance tasks. Since its introduction and mass adoption into service in many armies, the Russians have developed a possible replacement for the T-72 family of MBTs, the T-14 ARMATA, which shows a radical new design philosophy and some very advanced features. The 48-ton T-14 is armed with a more powerful variant of the Russian 125mm tank gun which, like variants of the T-72, can fire a guided missile through the tube to a range of up to 5,000 meters. It is propelled by a 1,500-horsepower diesel engine, which provides it with excellent mobility. The protection is also excellent, with the steel armor supplemented by a system of ERA bricks around its outer surfaces. Where the T-14 ARMATA radically departs from conventional designs is the fact that its three crewmembers are assembled in an armored capsule inside the hull, in front of the turret, which is unmanned and remotely controlled. This is meant to ensure better crew survivability in combat but some has criticized the fact that this puts the tank commander in a position where he no longer can have an all-around direct visual surveillance capability of the battlefield. This means that if the sensors used by the commander and the gunner are knocked out, then the tank effectively becomes blind. Finally, while paraded in Moscow in 2015, the T-14 apparently still has not entered Russian service in any numbers, making many wonder if Russia will be able to afford buying it in significant quantities. At present, the **T-14** has not seen combat, so is still mostly an unknown quantity to the West.

EUROPEAN MAIN BATTLE TANKS

Germany, the nation that was considered to have produced some of the best and most powerful tanks during WW2, did not resume work on new tanks until 1957, when it reached an agreement with France to jointly develop a standard European tank. This

eventually resulted in the **LEOPARD 1** main battle tank, which entered production for the German Army in 1963, with first deliveries in 1965. The LEOPARD 1 was armed with a 105mm rifled gun, was very agile and proved a big success worldwide, with a total of 4,500 tanks produced between 1963 and 1981, entering service with Germany, Belgium, Denmark, Italy, Netherlands, Norway, Greece, Turkey, Australia and Canada in progressively improved variants. In the process, its initial weight of 34.8 tons went up gradually to 42.4 tons for the final A4 variant. Germany also worked to develop in concert with the United States the MBT-70, a highly advanced tank design which included a 152mm gun-missile launcher. However, that program proved both too complex and costly and Germany withdrew from it in 1967 before deciding to launch alone its own new MBT program in 1970. The fruit of that program was the **LEOPARD 2** tank, which was armed with a 120mm smoothbore gun and used the new British Chobham armor. The first of 1,800 LEOPARD 2 tanks entered service with the German Army in 1979, with Switzerland also acquiring 380 of the new tanks. The LEOPARD 2 is still in service today in many variants, including the newest A7 model.

LEOPARD 1C2

LEOPARD 2A5

Contrary to most other countries after WW2, which developed both medium and heavy tanks, France decided to concentrate of a single category of tank, the medium tank, supplemented by light tanks. The French were then heavily influenced by the lessons learned from their encounters with the two outstanding German tanks of WW2, namely the PANTHER and the TIGER. The first post-war French program was the AMX-50, which introduced the concept of the so-called ‘oscillating turret’, in which the turret was split in two parts horizontally, with the upper part mounted on trunnions fixed to the lower part. The main gun was fixed to the upper part and elevated and depressed with it. This allowed the use of an automatic loader system in the turret bustle. The first prototype of the AMX-50 was built in 1949 and was armed with a 120mm gun.

Concurrently, the French developed the14.5-ton AMX-13 light tank, armed with a long 75mm gun and using the same kind of oscillating turret as the AMX-50, which allowed it to have a semi-automatic gun loading system. The AMX-13 went on to be adopted by many other armies, including Israel, Switzerland and India. Following the termination of the AMX-50 program in the mid-50s, France developed a lighter battle tank, the 36-ton **AMX-30**, armed with a 105mm main gun, which entered production in 1966. The successor of the AMX-30 and the current mainstay of the French Army tank fleet is the LECLERC main battle tank, which started being produced in 1991 and entered French service in 1992, with close to 800 in total built for the French Army and for the United Arab Emirates. The LECLERC is armed with a smoothbore 120mm gun similar to that of the LEOPARD 2 and of the M1A1 and which uses an autoloader system, which allows for a crew of three. With a mass turning around 57 tons, a diesel engine developing 1.500 horsepower and an advanced hydropneumatics suspension system, the **LECLERC** benefits from excellent mobility and has a powerful armament on par with other modern tanks. The armor is made of steel and composite plates, while later series include semi-reactive armor modules and some titanium armor. The LECLERC tanks operated by the UAE have fought in Yemen, where three of them were damaged but none destroyed. During a 2019 NATO exercise, the LECLERC outperformed both the American M1A2 ABRAMS and the German LEOPARD 2.

In 1956, Sweden started the development of a most unusual tank, the turretless **Strv-103 S-Tank**. The S-Tank relied on its suspension and driving system to point its fixed 105mm main gun. This resulted in a very low tank silhouette and a highly slopped

frontal upper glacis, thus making it more difficult to hit and destroy. It also allowed the use of an automated loader system for the gun and a crew of only three men. Furthermore, the S-Tank propulsion was via the combination of a diesel engine and of a gas turbine, used when peak power was required. The powerpack was installed in the front section and contributed to the protection of the crew. However, one major drawback of such a turretless tank is that it cannot engage a target while on the move, unless it was directly ahead. This eventually convinced the Swedish Army to adopt a more conventional tank, namely the LEOPARD 2, to succeed the S-Tank. The first production model of the Strv-103 was delivered in 1967, with 300 **S-Tank**s eventually delivered by 1971.

ISRAELI MAIN BATTLE TANKS

During the first two decades of its existence, Israel had to rely on second-hand or captured tanks and on some M-60A1 main battle tanks provided by the United States. Finally, in 1970, the Israeli government decided to start its own tank program, with two prototypes of the new MERKAVA MBT completed in 1974. The first MERKAVAs were delivered to the Israeli Army in 1979. The MERKAVA was then used in combat for the first time during the 1982 invasion of Lebanon, with an improved Mark 2 version following in 1983. The MERKAVA is a most unconventional main battle tank in many aspects. First, its diesel engine and transmission are located at the front, in order to provide extra protection to its crew. Second, the 120mm main gun ammunition is stored inside fire-proof containers in the rear section of the tank, next to a thick rear armored door, which allows easy ammunition replenishment and also provides an emergency escape route for the crew. While many articles mention the fact that the MERKAVA can carry a few infantrymen in its back section, that can be done only at the expense of removing most of the gun ammunition normally stored there, something that most tankers would intensely dislike to do in most circumstances. The front of the MERKAVA turret is highly profiled and sloped and has an unusually small frontal area for a 65-ton

machine. The large size and heavy weight of the MERKAVA was made acceptable to the Israelis, who wanted to emphasize protection, by the terrain particular to their area of the Middle East, which is mostly bone-dry and has few significant rivers flowing through it. The 1,200-horsepower diesel engine of the MERKAVA 3 provides it with good mobility. However, its size and weight would constitute a handicap during urban combat within narrow streets. As of today, a **MERKAVA 4** variant is in service with Israeli forces but no MERKAVAs have been exported outside of the country.

Many other countries around the World, notably around Asia, either produce or use main battle tanks, with many of those tanks being either copies or local adaptations of foreign designs (American, Russian, German). For the sake of simplicity and brevity, I will not attempt to cover those models in this essay.

CHAPTER 4 – THE MODERN MBT IN RECENT WARS

A Turkish LEOPARD 2 (German-made) main battle tank destroyed in Syria in 2020.

LEBANON AND SYRIA: NASTY SURPRISES

Recent fighting in the last few years around Lebanon and Syria brought some nasty surprises to the makers and users of modern main battle tanks reputed to be nearly invincible. One case was the destruction of a number of Turkish-operated LEOPARD 2 main battle tanks inside Syria, which fell victim to man-portable anti-tank guided missiles. The Turkish tankers, engaged in fights against Kurdish infantry, Syrian fighters and ISIS fanatics, found out to their sorrow that the way gun ammunition was stored inside their tanks made them vulnerable to a well-placed hit from a missile. That then convinced the Turkish forces to take their opponents more seriously and to become more tactically wary while moving around in the open.

In Lebanon and along its border with Israel, Hezbollah fighters armed with the latest Russian portable anti-tank missiles were able to damage or destroy a number of the mighty Israeli MERKAVA tanks, thus pouring some cold water on its reputation of invincibility. That particular lesson was a reminder that tanks operating without proper infantry support become vulnerable to close-in attacks by enemy infantry, particularly within built-up areas and densely-forested regions. It also showed that, however much

you add to the armor protecting a tank, the enemy will eventually develop a way to defeat that armor.

THE IRAQ AND AFGHANISTAN EXPERIENCES

While the initial phases of the 1990-91 Gulf War saw Allied tanks inflict a lopsided defeat in the field on the Iraqi Army, equipped with Soviet tanks, the fighting that followed inside Iraqi cities and the subsequent occupation of Iraq cost extra casualties to the Allies, due to the close-combat nature of urban fighting, where the Western advantage in superior long-range gunnery did not apply. The more fanatical and resolute Iraqi fighters who resisted the Allied occupation used close-in infantry ambushes, armed with RPG-7 anti-tank rocket launchers and improvised explosive devices to attack Allied vehicles. Some M1 tanks were knocked out by RPG-7s fired from building rooftops and highway overpasses which gave downward shots at the American tanks rolling down streets and avenues and thus presented them the weakest spots of those armored vehicles. In Afghanistan, the Coalition forces encountered a fanatical enemy who massively used mines and improvised explosive devices, or IEDs, placed along or under roads and trails and remotely detonated. Those IEDs often contained enough explosives to be able to flip over an armored vehicle or truck and caused hundreds of Coalition casualties.

THE LATEST: TANK HOLOCAUST IN UKRAINE

Starting on 24 February, 2022, the Russians invaded Ukraine with over 170,000 soldiers and thousands of armored vehicles, including hundreds of main battle tanks. However, the Russian advance, targeting mostly Kyiv, Kharkiv and the coastal area on the Sea of Azov and the Black Sea, quickly bogged down, blocking hundreds of Russian combat and service vehicles in huge road jams and thus offering juicy targets to Ukrainian soldiers, who started sniping at the immobilized columns with portable anti-tank missiles and anti-tank rocket launchers. The same thing happened when Russian armored and mechanized units started entering Ukrainian villages and city suburbs, where Ukrainian defenders skillfully used urban combat tactics to repeatedly ambush Russian tanks and armored personnel carriers (APC) with anti-tank missiles and rockets. As of early April, Russian tank losses were estimated to be over 300 main battle tanks destroyed, immobilized or captured, most of them being of the T-72 variety. This represents about a third of the Russian tank force that entered Ukraine at the start of the

invasion. However, the anti-tank weapons and tactics used by the Ukrainians were not the only factors in causing such heavy Russian tank losses. Significantly contributing to these Russian losses were the general Russian tactical incompetence, lack of fighting spirit, poor leadership and poor logistical support of the Russian frontal units. On the other hand, the Ukrainians lost an estimated eighty tanks, all of them of types similar to those used by the Russian Army, representing about twelve percent of their total tank force. So, while both sides basically used the same types of tanks, the Russians lost nearly three times the proportion of tanks lost by the Ukrainians. All these facts point in turn to a crucial element that has too often been neglected or ignored by too many in past wars: the human factor. In the case of this war, that factor included, among other things, troop morale, motivation, combat leadership, training levels, tactical competence and initiative and also the quality of higher-level leadership. In all of those domains Russian forces proved grossly deficient, something aggravated by wildly inaccurate intelligence assessments by Moscow on Ukrainian readiness and resolve. The Russians were not the only ones, by far, to so misjudge the Ukrainian capacity to resist and fight: many ‘experts’ and pundits in Washington and in other capitals had estimated at the start of the Russian invasion that Kyiv would fall within two to three days. Now, at the time of writing this after 35 days of war, Kyiv is still solidly in Ukrainian hands and the Russian forces around the city are being pushed back by a series of Ukrainian counter-attacks. Also, as Russian troops initially started to surround Kyiv, Washington officially offered to President Zelensky to fly him and his government to safety in Poland. Zelensky’s reply, which British Prime Minister Winston Churchill would have warmly applauded, was that ‘I don’t need a ride: I need ammunition’.

The first month of the war in Ukraine revealed the often-shoddy state and substandard performance of many pieces of Russian military equipment and weapons systems. As covered earlier on, Russian main battle tanks showed themselves prone to simply blowing up when hit by Ukrainian anti-tank missiles and rockets. Media reports and videos taken of the destroyed or abandoned Russian tanks revealed a few stunning facts, like the poor state of the reactive armor elements hooked to the sides of those tanks and

the generally poor level of maintenance that was evident. Also, there are reports that a significant percentage of the Russian air-to-surface missiles fired at Ukrainian targets malfunctioned and failed to destroy their targets. As well, a large number of Russian vehicles of all kinds broke down during their advance and had to be abandoned, while Russian soldiers complained of frostbites caused by the lack of proper winter gear and about long-expired rations or plain shortages of field rations, forcing them to steal food from Ukrainian shops and houses. A possible explanation for all this could be the endemic and widespread state of corruption within the Russian government system, including within the armed forces, with budgets meant to cover maintenance, supplies and spare parts possibly plundered by officials and senior officers. If that is the case, then it would also constitute part of what I call the human factor, but concerning a level much higher than that at the frontlines.

CHAPTER 5 – WHO WANTS TO KILL THE MBT? EVERYBODY!

A Ukrainian infantry squad armed with various portable anti-tank weapons.

Since its apparition on the battlefields of the First World War, the tank faced in the three decades that followed two main adversaries: artillery guns, either of the general field type or of the specialized anti-tank models, and other tanks armed with guns. Added to those two main rivals was the anti-tank landmine, a simple and inexpensive weapon that could be used anywhere and which proved effective in both blocking or diverting the advance of tanks. In WW2, huge battles opposed fleets of hundreds of tanks, with tank guns and anti-tank guns, either towed or self-propelled, causing much of the mayhem. In the deserts of North Africa, the anti-tank landmine emerged as an important weapon against tanks, but their effect proved indiscriminate, as minefields were equally dangerous to both sides. Then, midway during WW2, a new anti-tank weapon appeared: the man-portable anti-tank rocket launcher, exemplified by the American '**Bazooka**' and the German **PANZERFAUST** and **PANZERSCHRECK**.

However, those new weapons, while at last giving infantrymen a way to destroy enemy tanks attacking them, proved to have only very short effective ranges and also had an important signature due to their backblast. They used shaped charge warheads to damage or destroy tanks, thus needed large diameter warheads to be effective against heavy armor. The American M1 2.36-inch 'Bazooka' quickly proved useless against German heavy tanks due to its small caliber, so larger caliber weapons were developed. After the end of WW2, many countries went into the development and production of a wide variety of man-portable anti-tank rockets and anti-tank missiles. The wide proliferation of such weapons, particularly of anti-tank guided missiles, had pundits predict some thirty years later that the main battle tank had been rendered obsolete. However, their predictions eventually proved to be incorrect, as newer main battle tanks became better protected and added new protective measures, like spaced armor, composite armor and explosive reactive armor (ERA). Also, the first generation of anti-tank guided missiles were heavy, cumbersome and demanded lots of training for its shooters to be accurate. However, much progress has been made in developing truly portable, effective and easy to use anti-tank weapons, something that is being demonstrated in the war in Ukraine. Here are thus the weapons most feared by tanks today.

HIGH-VELOCITY TANK GUNS

The high-velocity main guns on modern main battle tanks, shooting armor-piercing long-rod penetrators, are still quite effective against modern tank armor and are much less affected by ERA armor than shaped charge warheads, on top of being effective as well against highly sloped armor plates. Modern MBT guns now range in caliber between 105mm, 120mm and 125mm, with projects for guns of up to 130mm or even 140mm. However, those tank guns are bulky heavy and quite long and generate a powerful recoil, on top of producing a muzzle blast that temporarily creates a thick cloud of dust and flames which obscures the sights of the tank gunner for a few seconds, impeding accurate rapid fire. Some tank guns, mostly Russian 125mm models, can fire anti-tank guided missiles through the gun tube.

ANTI-TANK GUIDED MISSILES

The biggest nemesis to modern main battle tanks is the latest generation of man-portable anti-tank guided missiles, like the American JAVELIN, Russian KORNET, European NLAW and Israeli SPIKE. These systems can defeat the armor of nearly all existing MBTs, or at least cause severe damage to them. They are also very accurate, easy to use and have ranges which can attain 2.5 kilometers or more in the heavier systems. Presently in Ukraine, the American JAVELIN and British-Swedish NLAW are the favored weapons of the Ukrainian Army and have been decimating Russian tank columns from the start of the invasion.

JAVELIN

NLAW

MAN-PORTABLE ANTI-TANK ROCKETS

Man-portable anti-tank rocket systems are another class of anti-tank weapons which has made big progress during the last few decades in terms of lethality, increased effective range and ease of carry and operation. While they have shorter effective ranges than portable guided missiles, they are much cheaper to acquire, demand much less maintenance and care and can all be carried and fired by one man. The more recent models, like the German PANZERFAUST 3, which is heavily used by the Ukrainian Army, can pierce as much armor as most anti-tank guided missiles, with up to 900mm of steel armor pierced. The PANZERFAUST 3 also has the benefit of being able to be fired from within enclosed spaces, which makes it an ideal ambush weapon in urban fighting. Another weapon widely used in the war in Ukraine is the venerable and ubiquitous Soviet-made RPG-7V, which entered service in 1958 but whose ammunition has been constantly improved to augment its effective range and armor penetration. Among its latest models of rockets, the PG-7VR has an effective range against moving

targets of 200 meters and has a tandem shaped charge warhead able to penetrate 600mm of steel, and this after passing through ERA reactive armor bricks.

PANZERFAUST 3

RPG-7V with PG-7VR tandem warhead rocket

FROM THE AIR: ATTACK HELICOPTERS, AIRCRAFT AND ARMED DRONES

Another deadly opponent of the main battle tank is the attack helicopter, armed with anti-tank guided missiles like the American **HELLFIRE,** able to decimate tank columns from distances of up to eight kilometers. Attack aircraft can also fire guided air-to-ground missiles which are lethal to main battle tanks, while a relatively recent trend is the use of remotely-piloted drones armed with anti-tank guided missiles, like the Turkish-built **BAYRAKTAR TB2** drone armed with anti-tank missiles, which is presently used by the Ukrainians against invading Russian forces.

LONG-RANGE GUIDED MUNITIONS

As if this was not enough, some field artillery guns and howitzers can fire special guided shells, like the American M712 CLGP COPPERHEAD of 155mm caliber, in indirect fire mode, with a forward artillery observer then guiding the missile by ‘painting’ a target, like a tank or a bunker, with a laser designator unit. In the case of the

COPPERHEAD, it can strike its target with pinpoint precision at ranges of up to sixteen kilometers and destroy the best protected tanks known.

155mm COPPERHEAD guided shell diving on a tank.

Impact of the COPPERHEAD shell on a tank.

THE GOOD OLD MINE AND THE IMPROVISED EXPLOSIVE DEVICE (IED)

While having been in use in war since the start of WW2, the anti-tank mine, now made out of plastic materials which can't be located by magnetic mine detectors, is still an effective anti-tank weapon, although it is an indiscriminate one that can blow up either enemy or friendly tanks or even civilian vehicles, depending on who is unfortunate enough to roll over it first. Modern anti-tank mines pack enough explosive power to either destroy or severely damage any tank and will also knock out the crew. Even after more than 76 years, old mines sown in WW2 around the deserts of North Africa still kill civilians unlucky enough to drive over them. Another weapon, widely used in recent conflicts in Afghanistan, Iraq and Lebanon, is the improvised explosive device, or IED in short. The IED has the virtue of being remotely-detonated, either by wire or by radio, and can be fabricated out of about any explosive, old shell or bomb one could find and fit with a detonating wire or a radio remote control device. While crude, IEDs have proved most deadly and difficult to detect if well sited and camouflaged.

Dug out old anti-tank land mines

Israeli MAGACH 7 tank destroyed by IED in Lebanon

URBAN COMBAT: A HELLISH ENVIRONMENT FOR MBTs

Most tank crews will tell you that fighting inside cities and villages is not something they enjoy, for many good reasons. First, direct lines of fire are severely limited, unless you happen to fire down a large boulevard or avenue, thus modern tanks lose most of the benefits brought by their sophisticated gun fire control systems. Second, the enemy infantry is given some golden opportunities to approach your tank undetected and with impunity from a variety of angles, unless you have some friendly infantry around to protect you at short ranges. Third, enemy soldiers can take position in the upper floors of buildings or even on the roofs, thus gaining positions giving them an overview of your tank and easy shots at your tank's roof, one of the least armored parts of any tank. Even an old grandmother armed with Molotov cocktails can sit on her balcony and throw incendiary bottles at you. Fourth, the streets can be easily blocked off by barricades and anti-tank obstacles like large concrete blocks, mines, IEDs, steel **Czech Hedgehogs** and anti-tank ditches dug into the pavement. The enemy can thus easily channel your tank into a killing zone by judiciously blocking a few well-chosen streets. Tanks that have to engage in urban fighting thus need to be closely accompanied by friendly infantry in order to prevent the enemy infantry from approaching your tanks undetected. Even when your force has overwhelming numerical and firepower superiority, a resolute and well-trained enemy infantry fighting from inside its own towns and villages can cause you endless headaches, along with some pretty painful losses, while minimizing their own casualties by using the cover of houses, high-rise buildings and underground tunnel networks.

CHAPTER 6 – WHAT NEXT FOR THE MAIN BATTLE TANK?

Now that we have reviewed the history and recent combat experience of main battle tanks, it is time to analyze those factors and decide what the future could have in store for modern MBTs.

THE LESSONS TO BE TAKEN INTO CONSIDERATION

As stated before, MBTs are presently judged mainly by three major qualities: firepower, mobility and protection. In terms of firepower, the present generation of MBTs are more than adequate in most cases, with powerful, high-velocity guns able to take out enemy tanks, vehicles, bunkers and other hard targets. However, that gun firepower comes at a price. Those tank guns in the 120-125mm caliber range weigh a couple of tons or more, not counting their support cradles and elevation mechanisms. With the present calibers in use, any future augmentation in caliber would result in rounds too heavy to be handled for any length of time by a human loader, while the total length of those bigger rounds would necessitate to split them into two loads: the projectile plus its propellant charge. Such split rounds would further slow down the rate of fire and would complicate the gun loading process, all this in the constricted internal space of the tank turret. High-velocity tank guns also have a hefty recoil and a length overall of about six meters or more, something that has to be taken into account when designing a new tank turret, so that the elevation limits of the gun inside the turret would not impact on the tactical effectiveness of the gun. This has already been a marked problem in Soviet-designed tanks, whose limited gun depression angles complicate their aim when engaging targets situated below their own tank location. The rather crude solution adopted by the Soviets for that problem was to carry a large log on their rear deck, so that the crew could put it down on the ground, just behind the tracks, and then roll in reverse over it in order to make the whole tank take a nose-down attitude. The reverse is also true, with the maximum elevation of tank guns being too limited to aim at any target past 15-20 degrees above them, like enemy tanks posted on a dominant ridgeline or snipers located on the upper balconies or roofs of surrounding buildings. Such elevation limits also impede the engagement at short ranges of enemy helicopters flying higher than treetop level. The solution to this would of course be to design the tank so that its gun would possess larger angles of elevation and depression but that would

greatly complicate the design of the turret and would also make the tank silhouette much higher, a definite negative point in tactical combat. Another limitation of existing modern tank guns is the limited variety of rounds they can carry and fire. Most tanks with 120-125mm guns normally carry only two kinds of gun rounds: an anti-tank long-rod penetrator round (armor-piercing, fin-stabilized, discarding sabot, or APFSDS in short) and a multi-purpose round able to take out vehicles with modest armor protection, bunkers and personnel in the open. The main exceptions to this are the British tanks, which use rifled 120mm guns able to fire multiple types of ammunition. However, those extra types of rounds severely impact on the limited overall number of rounds carried inside the tank, by lowering the number of anti-tank rounds considered as the main type of ammunition for a tank. In the case of Soviet tanks, like the T-72, T-80 and T-90, their carrousels can carry and load a few anti-tank guided missiles, on top of the normal high-velocity anti-tank rounds and multi-purpose rounds. Those gun-fired missiles also have some anti-helicopter capacity, a not negligible capability on the modern battlefield.

Added to the main gun armament of modern MBTs is a varied assortment of machine guns or grenade launchers, either coaxial to the main gun or on a top-mounted pintle mount or small top turret. Those secondary weapons are meant to deal with enemy infantry and soft targets, like trucks and other logistic support vehicles. This helps the tank to conserve its precious main gun ammunition for harder, more significant targets. The French AMX-30 demarked itself in that aspect by having a 20mm cannon rather than a medium machine gun as its coaxial weapon. All modern tanks also carry, attached around their turrets, a number of low-velocity, one-shot grenade dischargers, which can provide a nearly instant protective smoke screen around the tank as it retreats from enemy fire or changes tactical position. The Israeli MERKAVA is also special in that aspect, as it carries as well a small 60mm mortar as part of its secondary armament. However, the more diverse the armament on a tank, the more complicated the ammunition resupply problem becomes. The more advanced types of MBTs may also carry an active defense system which detects incoming projectiles and then fires special types of munitions to intercept and destroy those projectiles before they could hit the tank. However, the efficacy of such active defense systems still needs to be fully proven in combat.

Now, about mobility. Mobility may be the domain where most critiques could be made against modern MBTs. While their tactical mobility ranges from good to very good, with theoretical top speeds of up to ninety kilometers per hour on roads, their operational mobility is a lot more limited, while their strategic mobility positively sucks! The problem here is the sheer bulk and mass of modern MBTs, with widths of 3.5 meters or more and weights going from 45 tons all the way to 75 tons. This means that the width of all modern MBTs surpasses the standard rail gauges used in most countries (3.15m Berne International, 3.5m Western Europe with restrictions, 3.32m Soviet wide gauge), which in turn complicates any movement of tank units by rail, forcing railroad managers to temporarily restrict travel along parallel rail tracks. Also, only a portion of existing bridges and highway overpasses can support the mass of MBTs, which means that the movements of tank units along existing roads and bridges have to be carefully planned, further limiting the operational mobility of tank units. When it comes to movement by air, the problem becomes even more acute, with only a handful of heavy transport aircraft types being able to lift and carry a single MBT, at great cost in fuel. Sea movement via ro-ro type cargo ships is a lot more practical but such ships take a week or two to cross the oceans and deliver their loads to the operational theater. Once at destination, powerful low-bed semi-trailer trucks are then needed to carry the MBTs closer to the battlefields, in order to save from unnecessary wear the tracks and automotive components of the tanks. Finally, even at tactical level, tanks hate soft grounds, like mud, bogs and deep snow, with many of them ending up sinking into soft grounds and getting stuck. They also mangle the terrain behind their tracks to the point of making it impractical for wheeled vehicles to follow them. Just ask a European farmer what he thinks about tanks after a column of MBTs has just plowed through his fields during a military exercise and you will get some salty response from him. The only realistic solution to the mobility problem would be to significantly cut both the bulk and the mass of main battle tanks, something that cannot be done without affecting the protection level of the tank. A difficult tradeoff would thus be needed deal with that problem.

PROTECTION LEVELS: DESIRABLE VS REALISTIC

Next is the matter of protection level in a tank. Armor protection was the primary reason the tank was invented and used since WW1, in order to making it safer to cross the battlefield while under enemy fire. During WW2, the matter of armor protection levels was a bitter subject of discussion among Allied tankers riding American or British

medium tanks, like the SHERMAN and the CROMWELL, while having to face such scary monsters as the PANTHER and TIGER. The demand then was for ever more armor, which meant in turn heavier tanks and the need for bigger and more powerful engines in order to keep some acceptable level of mobility. This competition between firepower and protection continued after 1945, resulting in progressively bigger and heavier new tank designs, with the poor mobility factor stuck between those two other factors. Then came the advent of anti-tank guided missiles and rockets equipped with large caliber shaped charge warheads (HEAT) able to pierce about any existing tank at long range. That fueled another scramble for improved protection, resulting in the development of new types of armor able to better resist HEAT warheads, like spaced armor, multi-layered composite armor and explosive reactive armor (ERA). However, reactions inevitably trigger counter-reactions and the tandem HEAT warhead was then invented, in which a small precursory charge carried at the end of a nose probe of the missile, ahead of the main HEAT charge, causes the ERA bricks protecting a tank to detonate prematurely. Then, the main HEAT charge explodes and burns through the main armor. Now, many types of modern anti-tank missiles and rockets have such tandem HEAT warheads, thus rendering the utility of ERA questionable. Just look at pictures of Russian tanks destroyed by man-portable anti-tank weapons fired by Ukrainian infantrymen and you will see that nearly all of them are covered with ERA bricks. Yet, those Russian tanks had their turrets blown off after those missiles and rockets burned through their hulls and ignited their reserves of gun ammunition. So, what can be done to realistically limit the effectiveness and lethality of those modern portable anti-tank weapons? The honest answer is: not much. Claiming that more armor would solve that problem would be a fool's errand. As for the active protection systems touted for the newest generation of MBTs, I will say this: I will believe in them once they will have proved their efficiency on the battlefield. Too many variables are in play for us to rely only on theoretical studies and pre-arranged field trials. The best protection is still for the tank to not get hit in the first place, which in turn places a special premium on mobility, agility and small vehicle silhouette. A more fundamental question would be: how much protection is realistic vs desirable? The actual course to continuously add more armor to tanks and to bet on complicated and expensive active protection systems, with their own electronic sensors vulnerable to all the projectiles flying around the battlefield, while new anti-tank weapons continue to emerge, simply cannot go on for much longer.

THE MAIN BATTLE TANK: STILL AFFORDABLE?

Another criticism made about main battle tanks is their high unit cost, which is now in the multi-million dollar per tank and tends to blow the minds of national budget managers around the World, while the best man-portable anti-tank guided missiles can be had for a few thousands of dollars apiece. Here is a short list of the more modern types of MBTs in existence, with their approximate official unit cost, combat weight and width (the two latter factors directly affecting operational and strategic mobility):

- **T-64:** $1,1 million, 38 tons, width=3.415m
- **T-72:** $0,5 million, 41.5-44.5 tons, width=3.59m
- **T-80:** $3.0 million, 46 tons, width=3.6m
- **T-90:** $2.7-4.5 million, 48 tons, width=3.78m
- **T-14 ARMATA:** $3.7 million, 48 tons, width=3.5m
- **M1A2:** $8.9+ million, 67 tons, width=3.66m
- **CHALLENGER 2:** $5.53 million, 75 tons, width=4.2m (with appliqué armor)/3.5m
- **LEOPARD 2A7:** $5.74+ million, 66.5 tons, width=3.75m
- **LECLERC:** $4+ million, 57 tons, width=3.6m
- **MERKAVA IV:** $3.5 million, 65 tons, width=3.72m
- **TYPE 10 (Japan):** $15 million (you read right!), 48 tons, width=3.24m
- **K1 88 (S. Korea):** $2.0 million, 54.5 tons, width=3.6m

As you can see from that list, buying a fleet of modern MBTs, on top of paying for its maintenance and operation, is not something every country can afford. In the case of the new Russian T-14 ARMATA, first seen in a Moscow parade in 2015, it is still not in service in any sizeable quantity. One of the reasons proposed for that lack of T-14s in active service, apart from rumors of teething technological problems, is its high price, which the Russian government may not be able to afford in quantity. The recent economic sanctions and embargos on electronic parts inflicted on Russia after it started invading Ukraine will certainly not help in accelerating the putting into service of the T-14. So, for the moment, we may have to consider the Russian T-14 tank as merely a show piece.

WHAT WEAPONS?

Since the main goal of main battle tanks is to engage the enemy and destroy it, the question of its armament is certainly a primordial one when designing a new tank. To better decide what armament to put on a new tank, we have to consider what it will face in the field and in what conditions. Is the battlefield area constricted (built-up areas, forested areas, jungles, hilly country) or wide open (desertic areas, arctic tundra), or a mix of open and constricted areas? In that aspect, a country like Saudi Arabia will certainly not need the same kind of MBT than what Sweden or the Netherlands would need. Does the potential enemy have a modern anti-tank arsenal and modern tanks, attack helicopters, attack aircraft and armed drones? In the case of the war in Ukraine, the Ukrainian forces have proved to have all of these, so its opponent would have had to plan for the worst scenario in terms of Ukrainian resistance. While the invading Russian forces certainly had the types and quantities of weapons and equipment required to successfully invade Ukraine, their failings were more in how they used (or misused) their weapons, including their tanks, something that relates to the human factor. The Russians also failed to take into account all the modern portable anti-tank and anti-aircraft missiles which were being sent by the thousands to the Ukrainian forces by NATO countries and thus got badly burned right from the start. The fighting to date in Ukraine also pointed out some major problems with Russian equipment and armored vehicles. Russian tanks, while in theory well protected and extensively using ERA armor bricks, still blew up with disconcerting regularity when faced with portable anti-tank weapons like the JAVELIN, NLAW and PANZERFAUST 3. The Russian tanks could probably have used weapons better adapted to fight off the enemy infantry, like tank gun canister shells or remotely-operated machine gun mini-turrets. However, the best weapon for tanks against enemy infantry is still friendly infantry in close support. The Russian tanks, like other Russian vehicles, also proved vulnerable to the armed drones used by the Ukrainians, something that integral anti-aircraft missiles on Russian tanks could have helped them in fending off those drones. One notable point about tank guns is that their so-called multi-purpose shells, being of the HEAT-Fragmentation variety, are less lethal than artillery shells of the same caliber, producing less fragments and a smaller lethal radius. While most tanks have turret roof-mounted machine guns on pintle mounts, a crewman sticking his torso out in order to man it would quickly become a target for enemy riflemen and snipers hiding around the tank. A remotely-controlled turret would thus definitely be a better solution in that case. However, that raises the question of who would operate that mini-turret? In tanks crewed by three men, like the

T-72 or the LECLERC, that would add an extra task to a crew already barely large enough to fill all the basic combat functions of a tank. Even with a loader present as a fourth crewmember, having to man a machine gun turret would severely affect the rate of fire of the main gun. The point here is that close protection of tanks from enemy infantry is a very real and serious problem, one that has to be addressed. Contrary to the German soldiers of WW1, well-trained modern infantrymen can now fight on nearly equal terms with main battle tanks, if equipped with effective weapons and using good tactics. If the tanks are not able to obtain some friendly infantry as close escort, then they will have to assume that task by themselves, something that present modern MBTs are ill-designed to do, unless some imaginative tank commander decides to stick directional anti-personnel mines like the CLAYMORE all around the chassis of his tank and detonates them as he goes. Another solution would be to have extra smoke grenade dischargers fitted and loaded with HE-Frag grenades, which could then project a number of explosive grenades all around the tank, in order to pepper the enemy infantry with shrapnel. To recap, a main high-velocity tank gun and one or two machine guns may look sufficient at present to do the job for a MBT, but actual combat experience is showing that notion to be flawed.

WHAT KIND OF FUTURE: STAGNATION, EVOLUTION OR FADING AWAY?

If one goes by the various tank projects being presently pushed around the World, it seems that the trend towards ever bigger, heavier and more protected tanks will continue for at least a few years. No actual tank project is truly trying to break out of that mold, mostly due to ingrained conservatism among the senior military staffs, who are the ones establishing the desired specifications for new combat vehicles. Add to that the political interference by officials with no true understanding of what is needed in military terms and who are mainly preoccupied with obtaining juicy contracts for the defense industries established in their constituencies and the end product will often not reflect what is truly needed. Right now, the chances of seeing a truly revolutionary main battle tank design emerge somewhere and be adopted by a government are about zero for the next five to ten years. However, there are a few examples of hybrid types of combat vehicles, like the Russian BMPT TERMINATOR, that have appeared and are of interest. The BMPT TERMINATOR is classified as a ‘tank support fighting vehicle’ and was

designed for supporting tanks and other armored fighting vehicles inside urban areas. It is armed with four anti-tank missile launchers, two 30mm automatic cannons, two 30mm automatic grenade launchers and one coaxial medium machine gun. It is built on the chassis of the T-72 tank, is well protected and weighs 48 tons. It was first introduced into limited service in 2018, while a variant based on the chassis of the T-14 ARMATA tank and named '**BMPT TERMINATOR 3'** appeared in 2021. However, the BMPT is still not in widespread service and none of them have been seen in Ukraine, where they would undoubtedly have proved themselves useful if properly employed.

Finally, here is some dreaming of my own. What I imagine as a successor to the actual MBTs is a smaller, lighter, more mobile armored combat vehicle armed with a combination of missile launchers for long-range anti-tank and anti-helicopter/anti-aircraft combat, one 30mm automatic cannon to deal with enemy armored troop carriers and one large caliber, low velocity gun of a caliber of at least 150mm meant to fire highly destructive explosive rounds against bunkers and soft targets and to also ideally be able to fire as well guided missiles through the tube, with both the 30mm cannon and the large gun mounted together in a high elevation, compact turret. An automatic loader would be used to feed a mix of heavy rounds/missiles to the large gun, while two extra crewmembers, located in the rear, would man two mini-turrets armed with medium machine guns or automatic grenade launchers, with the task of protecting the vehicle on its sides and rear against infantry ambushes. A number of directional fragmentation mines could be fixed in armored boxes around the hull, to deal with approaching enemy infantry, and would be remotely-detonated by the vehicle commander. If enough space could be found inside the vehicle, a fire team of four infantrymen could ideally be carried, ready to dismount when needed. The vehicle could use a modern, compact but also powerful diesel engine like the MTU 890 Series, which would be located in the front of the vehicle, with the transmission, possibly of the electric drive type. This would both

keep the bulk and mass of the vehicle to a minimum, while allowing the use of the rear half of the vehicle for the combat systems and crew. It would also allow the base vehicle to be used to produce multiple variants for different roles. Since the actual armor vs weapon appears to be an endless and futile competition, the base armor would be designed to only resist automatic cannon shells and low velocity medium guns, in order to keep the vehicle's mass below forty tons, and ideally below thirty tons, so that the vehicle would be easier to transport by air and could roll on roads and bridges without mass constraints. I strongly believe that such a vehicle could be designed, as long as the designers and project managers show open minds and accept to leave the beaten tracks. I strongly believe that the actual MBTs could be better replaced by a combined arms armored combat vehicle (CAACV) as described above, able to deal by itself with the various threats found around the modern battlefield. Adopting such a type of vehicle would of course mean a rethinking of army combat doctrines and unit organizations, but I believe that a full integration of all combat arms in a single, homogeneous unit is a necessity rather than a dream. If that course is not eventually taken, then armies will continue to lose multi-million-dollar main battle tanks (and their crews) to foot soldiers armed with portable anti-tank weapons costing only a few thousand dollars each.

BIBLIOGRAPHY

- Richard M. Ogorkiewicz, Technology of Tanks, Jane's Information Group, Coulsdon, UK, 1991.
- Chris Bishop, The Encyclopedia of Weapons of World War II, Amber Books, London, UK, 2007.
- Bernard Crochet and Gérard Piouffre, L'essentiel de la Première Guerre Mondiale, Éditions Novedit, Paris, 2013.
- L'essentiel de la Seconde Guerre Mondiale, Éditions Novedit, Paris, 2013.
- Brigadier Peter Young, The Cassell Atlas of the Second World War, Cassell, London, 1999.